

COKE OVEN EMISSIONS*

First Listed in the *Second Annual Report on Carcinogens*

CARCINOGENICITY

Coke oven emissions are *known to be human carcinogens* based on sufficient evidence of carcinogenicity in humans (IARC V.34, 1984; IARC S.7, 1987). Epidemiologic studies have shown increased incidences of lung cancer in humans exposed to coke oven emissions. Mortality studies have demonstrated increases in lung and genitourinary system cancer among coke oven workers. An IARC Working Group also stated that there is limited evidence that such occupational exposures induce cancer of the kidney and that there is inadequate evidence for intestinal and pancreatic cancer (IARC V.34, 1984). EPA estimated that 1.5 to 16 lung cancer deaths per year are associated with exposure to coke oven emissions (Chem. Eng. News, 1984f).

An IARC Working Group reported that there is sufficient evidence of carcinogenicity of coke oven emissions in experimental animals (IARC V.34, 1984; IARC S.7, 1987). When administered topically, coke oven emissions induced skin carcinomas and papillomas in mice of both sexes. When exposure was by inhalation, coal tar aerosol from coke oven tar caused lung adenomas and squamous cell lung tumors in male mice and squamous cell lung tumors and skin tumors in female mice. Coal tar aerosol also induced squamous cell lung carcinomas in male and female rats when administered by inhalation. Chemical analyses of coke oven emissions revealed the presence of numerous known carcinogens and potentially carcinogenic chemicals, including 5 of the 15 polycyclic aromatic hydrocarbons (PAHs) listed in the *Ninth Report on Carcinogens* (see Polycyclic Aromatic Hydrocarbons, 15 Listings, Section III.B). Coke oven emissions also contain a variety of nitrosamines, coal tar, arsenic compounds, and benzene (see Soots, Tars, and Mineral Oils, Section III.A). In addition to carcinogens, coke oven emissions contain several agents known to enhance the effect of chemical carcinogens, especially on the respiratory tract (IARC V.34, 1984; IARC V.35, 1985).

PROPERTIES

Coke oven emissions are complex mixtures of coal and coke particles, various vapors, gases, and tars that include various PAHs, benzene, *o*-naphthylamine, cadmium, arsenic, beryllium, and chromium. OSHA defines coke oven emissions as the benzene-soluble fraction of total particulate matter present during destructive distillation or carbonization of coal to produce coke. A typical coke oven produces 80% coke, 12% coke oven gas, and 3% coal tar. PAHs generally constitute about 2 to 3% of the total particulates and 3 to 6% of the benzene soluble fraction.

USE

The primary use of coke is in the extraction of metals from their ores, especially iron. Coke is also used to synthesize calcium carbide and to manufacture graphite and electrodes (IARC V.34, 1984). Coal tar, a by-product of the production of coke from coal, is used in the clinical treatment of skin disorders such as eczema, dermatitis, and psoriasis (IARC V.35, 1985).

* There is no separate CAS Registry Number assigned to coke oven emissions.

PRODUCTION

In 1984, EPA estimated that between 330,000 and 3.5 million lb of coke oven emissions (benzene-soluble fraction) are produced annually (Chem. Eng. News, 1984f). Oven-charging operations and leakage around poorly sealed coke oven doors are the major sources of gaseous emissions from coke ovens. According to the Bureau of Mines, 64 U.S. plants operated about 13,000 coke ovens in 1970.

EXPOSURE

The primary routes of potential human exposure to coke oven emissions are inhalation and dermal contact. Occupational exposure may occur during the production of coke from coal or while using coke to extract metals from their ores, to synthesize calcium carbide, or to manufacture graphite and electrodes. Exposure to coal tar, a by-product of the production of coke from coal, could possibly occur during the production of coke or while using coal tar to treat skin disorders. Workers at coking plants and coal tar production plants, as well as the residents surrounding these plants, have a high risk of possible exposure to coke oven emissions. OSHA estimated that 10,000 coke oven workers were potentially exposed to coke oven emissions annually (NIOSH, 1976). Air sampling studies report concentrations ranging from 0.40 to 3.0 mg/m³ of coke oven emissions in the workplace.

A study presenting the 1979-1983 measurements of exposure of employees to coke oven emissions at a steel plant found the levels among selected job classifications to be as expected given the job descriptions and the coking process (Keimig et al., 1986). Larry car operator, lidman, and door machine operator, stationed very close to the oven, are exposed to volatiles released from the topside and side during charging and/or coke pushing and therefore have the highest mean breathing zone concentrations. Intermediate in the exposure rankings are the benchman-coke side and benchman-pusher side, who are exposed to volatiles through door leakage but are able to move away during the pushing operation. The group exposed to the lowest concentration consists of the pusher operator, quencher car operator, heater, and heater helper. The operators do not work close to the coke ovens, while the heater and heater helper, who regulate gas reversals and check the oven temperatures, are mainly found in the control room.

REGULATIONS

The Carcinogen Assessment Group at EPA has designated sludge from coking operations as a potential carcinogen, and these sludges are regulated under the hazardous waste disposal rule of the Resource Conservation and Recovery Act (RCRA). EPA has also listed components of coke oven emissions as hazardous air pollutants under the Clean Air Act (CAA). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) designates coke oven emissions as a hazardous substance and lists a final reportable quantity (RQ) of 1 lb for coke oven emissions. NIOSH has recommended a workplace standard of 0.1 mg/m³ as a 10-hr time-weighted average (TWA) concentration for exposure to the cyclohexane-extractable fraction of coal tar products and 0.5 to 0.7 mg/m³ for total particulates (NIOSH, 1996). The OSHA standard for coke oven emissions is a permissible exposure limit (PEL) of 0.15 mg/m³ as an 8-hr TWA. Under this standard, specific engineering and work practice control requirements became effective. OSHA has also promulgated a PEL of ≤ 0.2 mg/m³ as an 8-hr TWA for coal tar pitch volatiles. NIOSH and OSHA have recommended work practices to

minimize the harmful effects of exposure of coke oven emissions. Regulations are summarized in Volume II, Table A-17.